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SURVEY ON THE RELATION BETWEEN ROAD FREIGHT TRANSPORT, SCM AND SUSTAINABLE DEVELOPMENT

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Abstract: The purpose of this paper is to categorize research related to Supply Chain Management (SCM), road freight transport, and sustainable development and to classify treated papers in chronological order. The review is based on 50 articles published between 2000 and 2017 in international journals. The processing of the articles is done according to the defined characteristics of the article (date of publication, the journal title, the country, the research methodology adopted, the paper objective, the realized axes, and the indicators of follow-up). Although many studies have independently addressed the issue of sustainability, road freight, and supply chain management, there are fewer documents dealing with road freight transport and SCM in the context of sustainable development. Hence, this document will be very useful for researchers wishing to develop management or optimization approaches.

Keywords: Supply Chain Management, Road Freight Transport, Sustainable Development, CO2 Reduction, Conceptual.

MSC: 90B85, 90C26.

1. INTRODUCTION

The study of topics related to road freight transport, supply chain management, and sustainable development has attracted increasing interest from practitioners

and the research community, especially during the last decade [1]-[6].

This rise in interest is mainly due to growing environmental concerns, such as pollution that accompanies industrial development [7],decrease in raw material resources, overflow of waste sites, and increase in pollution levels [8]. In addition, other key factors such as government regulation, changing consumer demands, and the development of international certification standards [9] have gradually led companies to look at sustainable development initiatives with increasing attention.

However, although previous studies have made important contributions to the literature, there is still much to be learned about the management of the risks of road freight transport and its relationship with sustainable development in a supply chain management.

Nevertheless, it is interesting to note that research on these subjects has gradually increased, exposing the need to draw attention to environmental sustainability within companies that carry out logistics and transport activities in-house or entrust it to third parties [2].

According to the research carried out, there is little literature review that examines the freight road transport in a SCM in the framework of sustainable development.

Several articles have separately discussed the concept of SCM [10]-[19], sustainable development [20]-[26] or the road freight transport [1], [4], [27]-[37].

We also detected a review of the literature that deals with logistics and freight transportation in the context of sustainable development [6], a literature review on sustainable freight road transport [34] and sustainable supply chain management [2], [8].

Consistent with the above analysis, this paper aims to provide a review of contributions on the theme of environmental sustainability of the road transport perspective involved in the logistics process. More specifically, the main objectives are:

- classify research on this subject as a guide for practitioners and academics, based on the main characteristics of the documents analyzed (eg year of publication, title of the journal, regions concerned, and research methodology adopted).

- analyze papers dealing with the subject of road freight transport, SCM, and sustainable development.

The need to focus the current literature review on such a specific topic can also be explained by the following reasons: firstly, many literature reviews have focused on the treatment of SCM, sustainable development or transport. As such, we found it more useful to focus on a more limited scope and to do a thorough examination of the correlation of these concepts in a single job.

The paper is organized as follows. The following section provides the methodology adopted for this review. Section 3 presents and discusses the results of the review according to five key areas, namely, the country involved, the objectives of

the research, the method adopted, the axes developed, and the evaluation indicators chosen in each work. In the last section, conclusions are drawn and the limits of the research are identified.

2. METHODOLOGY

2.1. Scope of analysis

This analysis has focused on the literature on environmental sustainability in logistics and transport from the joint perspective of logistics management practitioners and researchers. In particular, we considered the perspective of the case studies made to manage the logistics chain as well as the initiatives of companies in the management of transport risks, and the role of associations and regulations to put into practice the principle of sustainable development.

In accordance with Srivastava [8], our analysis process includes the following steps:

- **Definition of the unit of analysis**: The unit of analysis has been defined as a single research document published in an international journal.
- **Classification Context**: We select and define the classification context to be applied in the literature review to structure and classify the material (ie SCM and road freight transport in a sustainable vision).
- **Material evaluation**: The material is analyzed and sorted according to the classification context. This helps to identify relevant issues and to interpret the results. The context of the problem and the methodology in relation to the related approaches allow the classification of the reviewed literature, which can be deductively or inductively derived.
- **Collection of publications and delimitation of the domain**: This review of the literature focused on articles in scientific journals. The starting point for the paper search was a number of library databases (i.e. Scopus, Science Direct, ISIWeb of Knowledge, Scirus, and Google Scholar). The search was carried out using important keywords such as SCM, road freight, sustainable development, sustainable logistics, CO2 reduction, Freight Road transport, which were searched in the abstract and the main body of an Article.

This method identified relevant research published in all major logistics and transportation journals, as well as environmental and energy journals. For example: Computers and Chemical Engineering, Computers and Operations Research, Computers in Industry, Decision Support Systems, Energy Policy, EuroMed Journal of Business, European Journal of Operational Research, European Journal of Operational Research, European Journal of Purchasing & Supply Management, Expert Systems with Applications, Industrial Management & Data Systems, International journal Production Economics, International Journal of Energy Sector

Management, International Journal of Management Reviews, International Journal of Physical Distribution & Logistics Management, International Journal of Production Economics, International Journal of Productivity and Performance Management, Journal of Cleaner Production, Journal of Manufacturing Technology Management, Management of Environmental Quality: An International Journal, Procedia Economics and Finance, Production Planning and Control, Resources, Conservation & Recycling, Simulation Modelling Practice and Theory, Supply Chain Management: An International Journal, The British Accounting Review, The International Journal of Logistics Management, Transport Policy, Transportation Research Part D: Transport and Environment, Transportation Research Part E: Logistics and Transportation Review.

- **Delimit the field**. As the number of references accumulated, it was found that some of them were more important than others. From this broad base, a subset of articles dealing directly with environmental sustainability, from the point of view of "supply chain" or "logistics and transport", was selected. Only articles whose main purpose was these subjects were selected, and therefore, articles that only mentioned them in their introductory remarks, or as collateral research topics, were excluded. In this subset, a smaller group of items was specifically identified as sustainability issues in the area of logistics and transportation activities, and only these were considered for the purposes of this review. In the end, 50 articles published from 2000 onwards were selected and examined in detail. The number of publications reviewed in this study appears to be sufficient given the scope of the analysis.

- **Material Assessment**: The material was analyzed and sorted according to the classification context. This helped identify the relevant issues and interpret the results. Specifically, articles that examine the implementation of environmental sustainability initiatives in logistics and transportation in a given enterprise (eg, case study or interview) and articles on the dissemination of environmental sustainability initiatives in different countries have been included. Articles presenting models to evaluate the impact of such initiatives on the company's activities were also included.

2.2. Review method

Different research methods are used in the following papers [3], [4], [8], [34], [42]-[44], according to Perego et al. [4]. For the purposes of our review, we ranked contributions using a two-pronged approach. On one hand, we classified the documents according to the research method or methods adopted. On the other hand, we examined the documents based on their content. As such, we first analyzed the selected literature to identify the main risks and emissions of road freight transport, and the presence of supply chain management and sustainable development, as well as the various theoretical or practical research on freight road transport in a supply chain management as part of a sustainable development approach. We then grouped the analysis around four key themes:

- The relevance of the topic related to SCM, Road freight, and sustainable development.
- The desired objective for each job.
- The research method (empirical, analytical, conceptual, reviews ...).
- The major axes realized in the work, the proposed evaluation indicators.

As a first step, we summarized the articles and then ranked the literature according to the review criteria to facilitate the identification of models that point to themes as well as possible gaps (Meixell and Norbis 2008a).

3. SUMMARY OF REVIEW AND DISCUSSION

We report a complete table (Table. 1), based on Natarajarathinam et al. (2009)[45], in which we summarize the content and characteristics of each article. The articles are arranged in chronological order to reflect the evolution of the issues of adoption of road freight transport, SCM, and sustainable development over time, as well as the applications and technologies gradually available on the market and of interest for the university community. In the following subsections, the articles reviewed are analyzed in terms of the research method and topic (s) addressed.

3.1. Main characteristics of the analysed papers

As shown in Table. 1, the 50 papers reviewed were published from 2000 in international peer-reviewed journals. Interestingly, most of the articles are relatively recent (21 were published from 2000 to 2010, 29 papers from 2011 to 2017), reflecting the growing interest of the research community (Fig. 1).

The articles reviewed were published in 31 different journals, displayed by article number for each paper Table. 2. We quote *Computers and Chemical Engineering, Computers and Operations Research, Computers in Industry, Decision Support Systems, Energy Policy, EuroMed Journal of Business, European Journal of Operational Research, European Journal of Purchasing & Supply, Expert Systems with Applications, Industrial Management & Data Systems, International journal Production Economics, International Journal of Energy Sector, International Journal of Management Reviews, International Journal of Operations & Production, International Journal of Physical Distribution & Logistics Management, International Journal of Production Economics, International Journal of Productivity and Performance Management, Journal of Cleaner Production.*

We also find several countries interested in the treatment of topics related to road freight transport, SCM, and sustainable development Table. 4, for example Canada (4 articles), France (5 articles), Italy (4 articles), United Kingdom (6 articles) , USA (9 articles).

In the following, the articles are categorized according to the research methods in Table 2 of Meixell et al. [44] and Perego et al. [4] In Table. 1 analysis, most

of the papers treat road freight transport in sustainable development, i.e SCM in a sustainable vision, but it is rare that the works deal with the study of road transport of goods in the sustainable development framework.

According to Table. 2, we identified several literature review papers that address the freight road transport, SCM, SD [46]; [47]; [45]; [7]; [48]; [4]; [49]; [5]; [50]. Meixell et al. [47] for exemple proposes a classification of research on transportation choices (choice of mode and choice of carrier) that will lead to an overview of the topics covered in the literature and directions for future research. Perego et al. [4] review a selected bibliography of information and communication technology (ICT) research for logistics and freight transport on the basis of the main themes and methods. Demir et al. [50] provide a review of recent research on green road freight transportation and present different factors affecting fuel consumption.

Conceptual and organizational research is relatively limited but gradually increases [51], [52], [3], [53], [54]. For exemple, Seuring et al. [3] offer a review of the literature on sustainable supply chain management by taking 191 articles published from 1994 to 2007.This study took a broad look at the sustainable management of the supply chain and emerging issues in this area, offers a conceptualization based on a review of the literature. Thus, Laarthe et al. [53] propose an agent modeling framework for the modeling and simulation of such supply chains to facilitate their management and to define the implementation and operation of an agent-based simulation model in a specific software environment. Similarly, themes related to sustainable development often focus on the same evaluation indicators, criticisms, and obstacles to be addressed.

Conversely, the articles dealing with the SCM concept seem to be more often based on an empirical approach, for example, logistic concepts and practice, and the selection of partners for the specific function of reverse logistics, and so on. In addition, we found several empirical articles on the level of adoption of sustainable development initiatives. This is the case of Lin and Ho [55] who conducted a questionnaire survey and examined three factors (technological, organizational, and environmental) influencing the intention to adopt green innovations for logistics service providers. Suzuki [35] developed a decision model designed to solve a variant of the vehicle routing problem, called the Pollution Routing Problem (PRP), to reduce the fuel consumption of trucks.

Table 1 also presents the presence or absence of the evaluation and monitoring indicators. We note that the treated papers use indicators like CO2 emission, load factor, capacity vehicle but there is a remarkable absence of the indicators in several paper.

3.2. Road freight transport, SCM, and sustainable approach

3.2.1. SCM with sustainability approach

The subject of sustainability initiatives appears to be the most discussed in the literature reviewed, addressed through both empirical (eg case studies) and conceptual approaches. In accordance with Murphy et al. [9], many companies

N°	Auteur (year)	title	Journal	Country	Research method	Work objective	The realization	Evaluation indicators
1	Croom, Simon Romano, Pietro Giannakis, Mihalis 2000 [56]	Supply chain management : an analytical framework for critical literature review	European Journal of Purchasing & Supply Management	UK	Empirical	- Contribute to a critical theory debate through the presentation and use of a framework for the categorization of literature linked to supply chain management	- Provide a taxonomy or topology of the field of supply chain management as an aid to both the classification of research in the field, and as a means of providing a framework for the identification of the key content of the subject	- Absent
2	Murphy, Paul R. Poist, Richard F. 2003 [9]	Green perspectives and practices : a "comparative logistics" study	Supply Chain Management : An International Journal	USA	Empirical	- Confirm literature suggestions that green concerns will broaden the scope of logistics as well as influence the way logistics managers do their jobs	- Comparing US and non US views and experiences regarding select environmental issues, policies, and strategies	- Reduce consumption - Reuse materials - Recycle materials - Redesign logistical system - Promote industry cooperative efforts - Use outside or third parties to manage environmental issues
34	Yan, Hong Yu, Zhenxin Cheng, T. C Edwin 2003 [57]	A strategic model for supply chain design with logical constraints : formulation and solution	Computers and Operations Research	China	Empirical	- Shows how the mixed integer programming modeling techniques can be applied to supply chain design	- Formulate the model which is a multi-commodity, multi-echelon, single-period mixed integer programming (MIP) model for the design of a supply chain - Analyze bills of materials (BOM) logical constraints - Illustrates representation of logical constraints in linear programming formulation - Solve a test problem	- Unit ordering cost - Unit transportation cost - Unit distribution cost
3	Shapiro, Jeremy F. 2004 [52]	Challenges of strategic supply chain planning and modeling	Computers and Chemical Engineering	USA	Modeling and organizational	- Provide a brief overview of the issues surrounding business process expansion to exploit fact-based strategic supply chain planning and its natural extensions to fact-based enterprise planning	- Expand the scope of studies and strategic supply chain planning models - Give thoughtful Theories of strategy in data-driven optimization models - Formalization of scenario planning, application of stochastic programming and risk modeling - Expanding business processes to exploit fact-based analysis of strategic plans	- Absent
4	Léonardi, Jacques Baumgartn er, Michael 2004 [58]	CO2 efficiency in road freight transportation : Status quo, measures and potential	Transportation Research Part D : Transport and Environment	Germany	Empirical	- Understand and measure efficiency improvements in the road freight transport sector	- Quantify the main parameters responsible for freight transport business efficiency in a field survey - Identifying the factor influencing successful implementation of efficiency measures	- Logistic efficient - Vehicle efficiency - Driver efficiency - Route efficiency

5	Fleisch, Elgar Tellkamp, Christian 2005 [59]	Inventory inaccuracy and supply chain performance : a simulation study of a retail supply chain	International journal Production Economics	Switzerland	Simulink	- Examine the relationship between inventory inaccuracy and performance in a retail supply chain.	- Simulates the impact of an erroneous inventory on supply chain performance - Investigated the impact of process quality, theft and unsaleable affect the inaccuracy of inventories, the level of out-of-stock and the cost of inventory inaccuracy.	- Benchmarking - Awareness building, process improvements - Radio frequency identification (RFID)
6	Labarthe, Olivier Espinasse, Bernard Ferrarini, Alain Montreuil, Benoit 2006 (Labarthe et al. 2006)	Toward a methodological framework for agent -based modelling and simulation of supply chains in a mass customization context	Simulation Modelling Practice and Theory 15	France	Modelling	- Propose an agent modeling framework for supply chain modeling and simulation - Adapt the modeling framework to a golf club industry and present an associated experience plan	- Define, implement and operate an agent-based simulation model in a specific software environment - Develop three levels of concern : conceptual, operational and experimental and define specific models for each level	- Evaluate the potential risks and the envisaged benefit
7	Caputo, A.C. Fratocchi, L. Pelagagge, P.M. 2006 [40]	A genetic approach for freight transportation planning	Industrial Management & Data Systems	Italy	Analytical	- Present a methodology to plan optimally road transport operations over long distances by combining properly customer orders in separate truckload or LTL to minimize total transportation costs	- Demonstrate the efficiency of evolutionary computing techniques in tactical planning of transport activities - Shows the possibility of significant savings on the overall cost of transport in a real life scenario	- Absent
8	Srivastava, Samir K. 2007 [46]	Green supply-chain management : A state-of-the-art literature review	International Journal of Management Reviews	USA	Reviews	- Present a review of the management of the green supply chain GRSCM integrating all activities in the region.	- Apply qualitative analysis to classify existing literature based on the context of the problem - Map the tools / techniques of the problem - Provide a calendar indicating the relevant documents for the benefit of academics, researchers and practitioners	- Green manufacturing & remanufacturing - Reducing/recycling/reman ufacturing - Reverse logistics
9	Mason, Robert Lalwani, Chandra Boughton, Roger 2007 [1]	Combining vertical and horizontal collaboration for transport optimization	Supply Chain Management : An International Journal	UK	Empirical	- Focus on customer driven supply chains and its relation with management of freight transport	- Explain the role of transportation in modern supply chain management and present an example of a case study dealing with lateral transport collaboration	- Efficiency - Asset utilization - Customer response
10	Meixell, Mary J. Norbis, Mario 2008 [47]	A review of the transportation mode choice and carrier selection literature	The International Journal of Logistics Management	USA	Review	- Categorize research on transportation choice (choice of mode and carrier selection) for an overview on the topics	- Develop a classification system for the different modes of transport - Provide a structured guide for future research and identify research issues for future investigation	- Absent

11	Vachon, Stephan Mao, Zhimin 2008 [20]	Linking supply chain strength to sustainable development : a country-level analysis	Journal of Cleaner Production journal	Canada	Empirical	- Investigates the important link between supply chain characteristics and sustainable development at the country	- Present the theoretical link between the strength of the supply chain and sustainable development	- Environmental performance : waste recycling rate ; energy efficient ; greenhouse gas emissions ; environmental innovation - Corporate environmental practices : the number of ISO 14001 certified facilities ; the participation in Responsible Care (chemical industry) ; the prevalence of green corporatism - Social sustainability : fair labor practices, corporate social involvement ; the Gini Index
12	Ciliberti, Francesco Pontrandolfo, Pierpaolo Scozzi, Barbara 2008 [2]	Investigating corporate social responsibility in supply chains : a SME perspective Francesco	Journal of Cleaner Production journal	Italy	Multi method	- Analyzes the practices adopted and difficulties experienced by Small and Medium-sized Enterprises (SMES) to transfer socially responsible behaviors to suppliers that	- Examine the practices and difficulties, respectively, adopted and faced by SMES to transfer socially responsible behaviors to the partners in their supply chains (SCs) - Conduct a multiple case study on five Italian socially responsible SMES.	- Absent
13	Hutchins, Margot J Sutherland, John W 2008 [60]	An exploration of measures of social sustainability and their application to supply chain decisions	Journal of Cleaner Production	USA	Multi method	- This paper reviews metrics, indicators, and frameworks of social impacts and initiatives relative to their ability to evaluate the social sustainability of supply chains - Explore the relationship between business decision-making and social sustainability	- This work adds to a growing discussion on how to incorporate the social dimension of sustainability into business decision making. - Understand the identification of critical variables, establish the conditions for the validity of the models and develop a weighting process for the indicators.	- Labor equity - Healthcare - Safety - Philanthropy
14	Seuring, Stefan Mu, Martin 2008 [3]	From a literature review to a conceptual framework for sustainable supply chain management	Journal of Cleaner Production	Germany	Review & conceptual	- Offers a literature review on sustainable supply chain management taking 191 papers published from 1994 to 2007 - Offers a conceptual framework to summarize the research	- This study has taken a broad look at sustainable supply chain management and the issues emerging in this field. It offers a conceptualization based on a literature review	- Legal demands/regulation - Customer demands - Response to stakeholders Competitive advantage - Environmental and social pressure groups Reputation loss
15	Chatfield, Dean C Harrison, Terry P Hayya, Jack C 2009 [51]	SCML : An information framework to support supply chain modeling	European Journal of Operational Research	USA	Conceptual	- Develop an open information standard to assist supply chain modeling, analysis, and decision support. - Develop several pieces of software to aid both users and developers in the utilization of SCML	- Present an overview of Supply Chain Modeling Language (SCML) - Discusses technologies for creating and processing SCML files, and describe a sample SCML-compliant application	- Absent

16	Natarajarathinam, Malini Capar, Ismail Narayanan, Arunachalam 2009 [45]	Managing supply chains in times of crisis : a review of literature and insights	International Journal of & Physical Distribution Logistics Management	USA	Literature review	- Describe the current practices and research trends in managing supply chains in crisis. This paper also provides directions for future research in supply chain crisis management.	- Given the state-of-the-art of research in the field of managing supply chains during crisis, there are many research areas that needs further investigation, such as recovery planning and scales for crisis management	- Absent
17	Cholette, Susan Venkat, Kumar 2009 [61]	The energy and carbon intensity of wine distribution : A study of logistical options for delivering wine to consumers	Journal of Cleaner Production	USA	Empirical	- Use a web-based tool, cargo scope, to calculate the energy and Carbone emissions associated with each transportation link and storage echelon	- Provide an overview of the U.S. wine distribution system - Construct a representative network to model delivery of specialty wines to end consumers both nearby and cross-country - Introduce the software used to estimate the energy usage and carbon emissions associated with these delivery scenarios - Show how different supply chain configurations can impact emissions	- Absent
18	Mckinnon, A C Ã Piecyk, M I 2009 [7]	Measurement of CO 2 emissions from road transport : A review of UK experience	Energy Policy	UK	Review	- This paper examines the various methods of carbon auditing road freight transport at the national level and compares the results both for a single year (2006) and over a time period.	- Define road freight transport - Explain the Dimensions of variability in CO_2 estimates for road freight transport	- Distance travelled - Average fuel efficient
19	Piecyk, Maja I. McKinnon, Alan C. 2010 [62]	Forecasting the carbon footprint of road freight transport in 2020	International Journal of Production Economics	UK	Empirical	- To determine the baseline trends in logistics and supply chain management and associated environmental effects up to 2020	- To classify factors affecting freight transport demand, truck fuel consumption and associated CO_2 emissions into six categories based on different levels of logistic decision-making - To build three scenarios to assess the CO_2 emission levels of road freight transport in 2020	- Weight of goods produced/ consumed - Weight of goods transported by road - Road tones-lifted - Road ton- kilometers - Fuel consumption - CO_2 emissions
20	Sarac, Aysegul Absi, Nabil Dauzre-Prs, Stphane 2010 [48]	A literature review on the impact of RFID technologies on supply chain management	International Journal of Production Economics	France	Review	- To give a state-of-the-art on RFID technology deployments in supply chains is given to analyze the impact on the supply chain performance.	- Give the Different approaches to evaluate the benefits of RFID technologies in supply chains - Explain the Potential benefits of RFID technologies in supply chains RFID	- Return-on-investment (ROI) - Benefits Revenue - Costs Hardware

21	Estampe, Dominique Lamouri, Samir Paris, Jean-Luc Brahim-Djelloul, Sakina 2010 [15]	A framework for analysing supply chain performance evaluation models	International Journal of Production Economics	France	Analytical	- Present article analyzes various models used to assess supply chains by highlighting their specific characteristics and applicability in different contexts - Offers an analytical grid breaking these models down into seven layers	- Suggested a table displaying various performance evaluation models organised by the model's origin, the type of analysis used, relevant conditions and constraints, the degree of conceptualisation and the indicators being devised. - A second comparison has incorporated criteria such as the level of decision-making, the specific flows in question, the relationship between performance and supply chain maturity levels, interest in the quality dimension, human competency and sustainability.	- Supply chain operation (scor) - Global supply chainforum (gsf) - Efficient consumer response (ecr) - Bsc : balanced scorecard
22	Perego, Alessandro Perotti, Sara Mangiaracina, Riccardo 2011 [4]	ICT for logistics and freight transportation : a literature review and research agenda	International Journal of Physical Distribution & Logistics Management	ITALY	Reviews	- To classify research on information and communication technology (ICT) for logistics and freight transportation on the basis of the main themes and methods	- Examine 44 research contributions, published between 1994 and 2009, - Development of a structured review that provides a guide to earlier research on the subject of ICT for logistics and freight transportation	- Absent
23	Yamada, Tadashi Imai, Koji Nakamura, Takamasa Taniguchi, Eiichi 2011 [14]	A supply chain-transport super network equilibrium model with the behavior of freight carriers	Transportation Research Part E	Japan	Analytical	- To present a super network equilibrium model integrating supply chain networks with a transport network, namely, a supply chain-transport super network equilibrium model.	- Propose a supply chain-transport super network equilibrium (SC-T-SNE) model, which is a sort of supply chain network equilibrium SCNE model, allowing the interaction of behavioral changes of agents in the SCNs and traffic conditions in the transport network to be taken into account	- Absent
24	Demir, Emrah Bektaş, Tolga Laporte, Gilbert 2011 [50]	A comparative analysis of several vehicle emission models for road freight transportation	Transportation Research Part D : Transport and Environment	Canada	Multi method	- This paper reviews and numerically compares several available freight transportation vehicle emission models - Considers their outputs in relations to field studies.	- Compare a number of models that have been developed to look at the fuel consumption and greenhouse gas emissions associated with road freight transportation. - The models produce somewhat different results in simulations using broadly realistic assumptions, but overall are consistent with expectations	- Acceleration fuel consumption - Deceleration fuel consumption - Cruise fuel consumption - Fuel consumption while idle - Fuel consumption with speed
25	Kuo, Yiyo Wang, Chi-Chang 2011 [63]	Optimizing the VRP by minimizing fuel consumption	Management of Environmental Quality: An	Taiwan	Analytical	- To optimize the routing plan with minimizing fuel consumption	- Propose a model to calculate the total fuel consumption during the development of a routing plan	- Transportation distance, - Transportation speed - Loading weight

26	Chaabane, Amin Ramudhin, Amar Paquet, Marc 2011 [64]	Designing supply chains with sustainability considerations	Production Planning and Control	Canada	Analytical	- Presents a comprehensive methodology to address sustainable supply chain design problems where carbon emissions and total logistics costs are considered in the design phase	- Introduces the problem and presents an overview of the literature in the area of sustainable supply chain design - Presents a multi-objective mixed integer model to support decision makers in the generation of different supply chain configurations and the evaluation of their performances with respect to economic and environmental constraints	- GHG emissions - Total logistics cost - Environmental impact
27	Wang, Fan Lai, Xiaofan Shi, Ning 2011 [65]	A multi-objective optimization for green supply chain network design	Decision Support Systems	China	Analytical	- Propose a multi-objective optimization model that captures the trade-off between the total cost and the environment influence	- Provide a multi-objective mixed-integer formulation for the supply chain network design problem. - Apply a normalized normal constraint method, which conduct a comprehensive set of numerical studies and characterize the pareto solutions especially their sensitivities to various parameters	- Total cost - Environmental protection investment - Total transportation cost - Total handling cost - Total CO_2 emission
28	Ageron, Blandine Gunasekaran, Angappa Spalanzani, Alain 2012 [66]	Sustainable supply management : An empirical study	International Journal of Production Economics	France	Empirical	- Explain the importance of sustainability in supply management	- Develop a theoretical framework - Study the framework by means of an empirical study using perceptions and practices of selected French companies	- Customer satisfaction - Supplier's capabilities to innovate Quality - Trust in suppliers - Upstream supply chain risk management Fill rate - Reduction of stock Flexibility - Order fulfillment costs Supplier lead-time
29	Oberhofer, Peter Fürst, Elmar 2012 [67]	Environmental management in the transport sector : findings of a quantitative survey	Euro Med Journal of Business	Austria	Multi method	- Examine the status quo of environmental management(EM) in the Austrian road freight transport sector	- Analyze differences between companies declaring themselves to practice EM actively and others which do not - Focus on managers' attitudes toward EM measures and evaluate different environmental measures	- Load factor optimization/ econ's of scale - Pollution reduction - Computerized route planning - Efficiency programs for vehicles - Greenhouse gas neutralization
30	Smith, T. W. Axon, C. J. Darton, R. C. 2013 [68]	A methodology for measuring the sustainability of car transport systems	Transport Policy	UK	Case study	- Identify stakeholder groups, the full range of impacts in the environmental, economic and human / social domains of sustainability, and those that generate and receive these impacts.	- Quantify the sustainability performance of the UK car fleet as it changed over a recent 10-year period - Apply a Process Analysis Method (PAM) to the UK car fleet to generate a set of sustainability indicators for car-based transportation	- Fuel energy consumption - Embodied emissions in vehicles added to the flee - Embodied emissions in fuel consumed

31	Zolfpour-Arokhlo, Mortaza Selamat, Ali Hashim, Siti Zaiton Mohd 2013 [69]	Route planning model of multi-Agent system for a supply chain management	Expert Systems with Applications	Malaysia	Multi method	- Analyze the effectiveness of the coordination model of the environmental conditions that are affecting for the travelling time based on multi-agent system for a road transportation network for supply chain management.	- Present a Route planning model for SCM - Propose a Multi-agent system (MAS) for supply chain management	- Traffic Load Estimation Agent (TLEA) - Type Of Road Agent (TORA) - Safety Of Road Agent (SORA) - Trip Time Estimation Agent (TTEA)
32	Pan, Shenle Ballot, Eric Fontane, Frédéric 2013 [70]	The reduction of gas greenhouse emissions from freight transport by pooling supply chains	International Journal of Production Economics	France	Analytical	- Explore the environmental impact of pooling of supply chains at the strategic level	- Presents the methods to compute CO_2 emissions from transport and the optimization model - Discuss the emissions results and economics results and associated analyses with the conclusions following	- Road transport emissions - Transport cost - Rail transport emissions
33	Taticchi, Paolo Tonelli, Flavio Pasqualino, Roberto 2013 [49]	Performance measurement of sustainable supply chains	International Journal of Productivity and Performance	UK	Review	- Develop the body of knowledge in the area of sustainable supply chains by providing a critical literature review in the field of sustainable supply chain performance measurement (SSCPM)	- Review the existing literature assessing the - Sustainable Supply Chain (SSC) and Performance Measurement (PM) developments	- Absent
35	Marchet, Gino Melacini, Marco Perotti, Sara 2014 [5]	Environmental sustainability in logistics and freight transportation	Journal of Manufacturing Technology Management	Italy	Review	- To categorize the research on environmental sustainability in logistics and transportation on the basis of the main themes and study methods	- Identify the main initiatives related to the creation of a sustainable supply chain - Underlines the fact that environmental performance measurement systems often focus only on the "visible" company-oriented metrics	- Absent
36	Lee, Ki hoon Wu, Yong 2014 [71]	Integrating sustainability performance measurement into logistics and supply networks : A multi-methodological approach	The British Accounting Review	Australia	Multi method	- Seek the way in which economic and environmental performance can be measured simultaneously - Take a multi-methodological approach to the logistics and supply chain management field in order to address sustainability challenges	- Give a review of the literature on sustainability performance measurement and - Its link to green logistics and sustainable supply chains - Present the multi-methodological approach and illustrate its application using an Australian case	- CO_2 emissions - Traffic congestion - Community amenity - Transport time
37	Demir, Emrah Bektaş, Tolga Laporte, Gilbert 2014 [72]	A review of recent research on green road freight transportation	European Journal of Operational Research	Netherlands	Review	- Provides a review of recent research on green road freight transportation.	- Present the Factors affecting fuel consumption - Treat the Fuel consumption modeling in road transportation planning	- Absent
38	Franco, Sainu Ravibabu Mandla, Venkata 2014 [33]	Analysis of road transport energy consumption and emissions : a case study	International Journal of Energy Sector Management	India	Case study	- Examine the growing energy consumption pattern and emissions due to increasing vehicular density in the Vellore district	- Make A study of the past four years shows a tremendous growth in the number of two-wheelers, while the number of buses has declined - The study also shows that public transport fuel consumption is<20 per cent of the overall fuel consumption	- Fuel efficiency - Passenger kilometer - Technical aspect of fuel efficient - Distance - Quantification of emissions

39	Andrés, Lidia Padilla, Emilio 2015 [73]	Energy intensity in road freight transport of heavy goods vehicles in Spain	Energy Policy	Spain	Empirical	- Examines the factors that have influenced the energy intensity trend of the Spanish road freight transport of heavy goods vehicles over the period 1996–2012	- Discusses the database used of the Spanish Continuing Survey of Road Goods Transport - Describes the results of energy intensity analysis. - Presents the results of the decomposition analysis and its extension.	- Energy consumption of road freight - Energy intensity in year
40	Liotta, Giacomo Stecca, Giuseppe Kaihara, Toshiya 2015 [74]	Optimization of freight flows and sourcing in sustainable production and transportation networks	International Journal of Production Economics	Denmark	Empirical	- Presents a model integrating supply, production networks and sustainable freight transportation for strategic and tactical decision- making. Bill-of-materials constraints are included in the model	- Presents the state of the art of optimization models integrating production and transportation problems - Discusses the integration of sustainability metrics and the work contribution - Compare transportation cost and carbon dioxide (CO_2) by mode per Tone-Kilometer (TKm).	- Emissions (gCO2/tkm) - Transport cost (EUR/tkm) - Increase in CO_2 emissions - Transportation costs - Inventory costs
41	Yamada, Tadashi Febri, Zukhruf 2015 [75]	Freight transport network design using particle swarm optimization in supply chain-transport super network equilibrium	Transportation Research Part E : Logistics and Transportation Review	Japan	Analytical	- Presents a discrete network design problem for optimally designing freight transport network in terms of the efficiency of supply chain. Modelling	- Presented a model that helps efficiently design a freight TN by identifying and selecting a suitable set of Transport Networks (TN) improvement actions from a number of possible choices, such as the renovation of existing transport-related infrastructure and the establishment of new roads	- Absent
42	Ivascu, Larisa Mocan, Marian Draghici, Anca Turi, Attila Rus, Simona 2015 [25]	Modeling the green supply chain in the context of sustainable development	Procedia Economics and Finance	Romania	Empirical	- Presents research about green supply chain management and highlight the differences between green supply chain and traditional supply chain management. - The paper analyses the sources of the risk in green supply chain according to the sustainable development	- Systematizes data relating to supply chain in Romania and the EU - Modeling the supply chain process is presented its architecture	- Absent
43	Liimatainen , Heikki Hovi, Inger Beate Arvidsson, Niklas Lasse Nykänen 2015 [76]	Driving forces of road freight CO_2 in 2030	International Journal of Physical Distribution & Logistics Management	Finland	Study case	- Knowing the factors influencing the long-term future development of CO_2 emissions from road freight	- Performing a Similar International Comparison of Delphi Surveys in Finland, Norway and Sweden	- Gross domestic product (GDP) ; - Value density ; - Road's share of total tones transported ; - Average length of haul on laden trips on road ; - Average load on laden trips on road ; - Share of empty running of total mileage ; - Average fuel consumption ; - Share of biofuels of total energy.

44	Jin-Hyuk Chung, Yun Kyung Bae , Jinhee Kim 2016 [77]	Optimal sustainable road plans using multi-objective optimization approach	Transport Policy Journal	Republic of Korea	Multi method	- Take the three dimensions simultaneously into consideration in road network planning by developing a Pareto multi-objective optimization model	- Develop a multi-objective optimization model to plan the optimal improvement of road capacity - Elaborate indicators for measuring each dimension of road network sustainability - Describes the details of the genetic algorithm used to solve the proposed multi-objective problem	- Total travel cost - Total emissions cost - Gini coefficient
45	Ivanov, Dmitry Pavlov, Alexander Dolgui, Alexandre Pavlov, Dmitry Sokolov, Boris 2016 [78]	Disruption-driven supply chain (re) - planning and performance impact assessment with consideration of pro - active and recovery policies	TRANSPORTATION RESEARCH PART E	Germany	Empirical	- Develop an approach to re-planning the multi-stage supply chain (SC) subject to disruptions	- Analyze seven proactive SC structures - Compute recovery policies to re-direct material flows in the case of two disruption scenarios - Assess the performance impact for both service level and costs with the help of a SC - Explicit connection of performance impact assessment and SC plan reconfiguration	- Revenue - Transportation costs - Inventory holding costs - Return costs - Fixed costs - Upstream costs - Recovery costs - Processing costs
46	Avci, Mualla Gonca Selim, Hasan 2016 [79]	Computers in Industry A multi -agent system model for supply chains with lateral preventive transshipments : Application in a multi-national automotive supply chain	Computers in Industry	Turkey	Empirical	- Develop a multi-agent system model to observe the effects of ordering parameters on a supply chain with lateral preventive transshipments.	- Provide a brief introduction of multi-agent modeling of supply chain systems and recent related studies - Present a multi-agent system model - Describe an implementation of multi- agent system model to focal supply chain - Demonstrate a simulation experiments and results for the focal supply chain	- Supplier flexibility - Safety stock
47	Suzuki, Yoshinori 2016 [35]	A dual -objective metaheuristic approach to solve practical pollution routing problem	International Journal of Production Economics	USA	Multi method	- Develop a decision model that is designed to solve a variant of the standard vehicle routing problem, called the pollution routing problem (PRP) to reduce trucks' fuel burn	- Reviewing pollution routing problem (PRP), literature and obtaining expert opinions from carrier managers - Develop an effective solution technique for PRP model - Present the Factors Affecting Fuel Consumption	- Energy consumption and carbon dioxide emissions - Road gradient - Congestion
48	Qian, Jiani Eglese, Richard 2016 [80]	Fuel emissions optimization in vehicle routing problems with time-varying speeds	European Journal of Operational Research	U.K	Empirical	- To minimize the total emissions in terms of the amount of Greenhouse Gas (GHG) produced, measured by the equivalent weight of CO_2.	- Propose a solution method uses a column generation based Tabu search algorithm - Present an experimentation with real traffic data	- Fuel efficiency - Speed adjustment & path selection - Starting time & waiting time

49	EL BAZ, Jamal Laguir, Issam 2017 [31]	Third party logistics providers (TPLs) and environmental sustainability practices in developing countries: the case of Morocco	International Journal of Operations & Production Management	Morocco	Case study	- Examine the environmental sustainability practices of Third-Party Logistics providers (TPLS) in a developing country and analyze the efforts made by TPLS to implement green practices through a case study of Moroccan TPLS	- Provides a review of the extant literature on environmental sustainability initiatives in TPLS and the logistics service industry - Introduce the research method and analytic procedure and report the results of the analyses	- The energy index efficiency - The use of renewable sources - The noise impacts calculation
50	Carvalho, Helena Govindan, Kannan Azevedo, Susana G Cruz-machado, Virgílio 2017 [81]	Modelling green and lean supply chains: An eco-efficiency perspective	Resources, Conservation & Recycling	Portugal	Multi method	- Proposes a model to support decision making and to help managers identify the best set of green and lean supply chain management practices to improve their eco-efficiencies	- Suggest a mathematical model based on eco-efficiency concepts to overcome the trade-offs between lean and green practices - Present a case study from an automotive supply chain	- Geographic concentration with suppliers - ISO 14001 - Just-in-sequence production

Table 1: Research summary

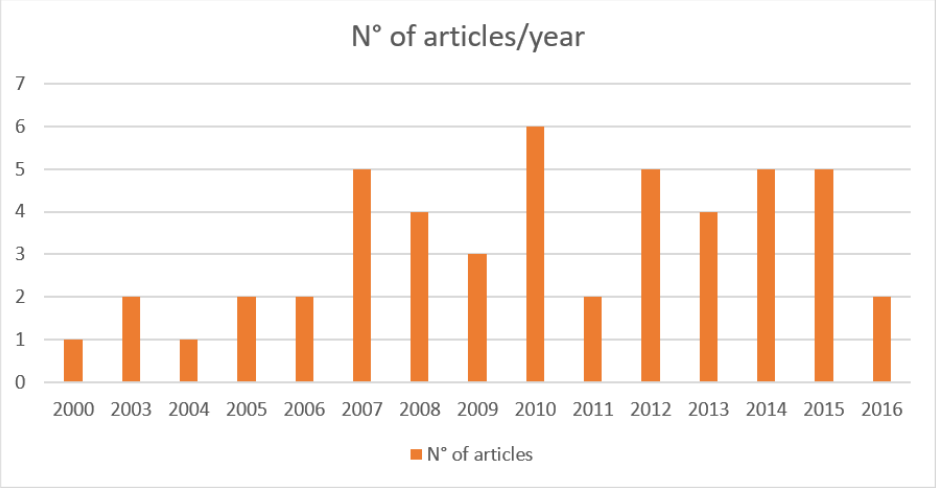

Figure 1: Number of article per year

operating in different supply chains have taken initiatives for environmental sustainability.

In order to deliver products and services to customers more environmentally,logistics service providers need to address more efforts on environmental issues[30],[55]. For instance, united parcel service (UPS), a global logistics sevice provider, uses route planning software and an internet matching system in their logistics service process to reduce the emission of greenhouse gas as well as to save fuel comsumption [8].

According to Ageron et al. [66], Green Supply Chain Management (GrSCM) is generating increasing interest among researchers and practitioners in operations and supply chain management. The growing importance of GrSCM is mainly due

Methodology	N of articles	%	Papers
Analytical	8	16	Caputo et al.(2006); Estampe et al.(2010); Yamada et al.(2011) ; Kuo et al. (2011); Chaabane et al. (2011); Wang et al.(2011); Pan et al.(2013); Yamada et al. (2015)
Study cases	4	8	Smith et al. (2013); Franco et al.(2014); Liimatainen et al. (2015); EL BAZ et al. (2017)
Conceptuel	1	2	Chatfield et al.(2009)
Empirical	15	30	Croom et al.(2000); Yan et al.(2013); Murphy et al.(2003); Léonardi et al.(2004); Mason et al.(2007); Vachon et al.(2008); Cholette et al.(2009); Piecyk et al.(2010); Ageron et al. (2012) ; Andrés et al.(2015) ; Liotta et al.(2015); Ivascu et al.(2015); Ivanov et al.(2016); Avci et al. (2016); Qian et al.(2016)
Reviews	9	18	Srivastava et al.(2007); Meixell et al.(2008); Natarajarathinam et al.(2009); Mckinnon et al.(2009) ; Sarac et al.(2010); Perego et al.(2010); Taticchi et al. (2013); Marchet et al. (2014); Demir et al.(2014)
Modelling and organizationel	2	4	Shapiro et al.(2004) Seuring et al. (2008)
Multimethod	9	18	Ciliberti et al.(2008); Hutchins et al.(2008); Demir et al. (2011); Oberhofer et al. (2012); Zolfpour-Arokhlo et al.(2013); Lee et al. (2014); Jin-Hyuk Chung et al. (2016); Suzuki et al.(2016); Carvalho et al.(2017)
Simuling	2	4	Fleisch et al.(2005) ; Labarthe et al.(2006)
Total (50 articles)	50	100	

Table 2: Research methodology

to the increasing deterioration of the environment, for example, the decrease in raw material resources, the overflow of waste sites and the increase in pollution levels. However, it is not only to be environmentally friendly, it is about good business sense and higher profits. In fact, it is a value engine and not a cost center. In addition, regulatory requirements and consumer pressures guide GrSCM. Thus, the GrSCM extends from reactive monitoring of general environmental management programs to more proactive practices implemented by various Rs (Reduce, Reuse, Rework, Recondition, Recover, Recycle, Remanufacture, Reverse Logistics, etc.).

Journal name	Number of articles
Computers and Chemical Engineering	1
Computers and Operations Research	1
Computers in Industry	1
Decision Support Systems	1
Energy Policy	2
EuroMed Journal of Business	1
European Journal of Operational Research	3
European Journal of Purchasing & Supply	1
Expert Systems with Applications	1
Industrial Management & Data Systems	1
International journal Production Economics	1
International Journal of Energy Sector	1
International Journal of Management Reviews	1
International Journal of Operations & Production	1
International Journal of Physical Distribution & Logistics Management	3
International Journal of Production Economics	7
International Journal of Productivity and Performance Management	1
Journal of Cleaner Production	5
Journal of Manufacturing Technology Management	1
Management of Environmental Quality: An International Journal	1
Procedia Economics and Finance	1
Production Planning and Control	1
Resources, Conservation & Recycling	1
Simulation Modelling Practice and Theory	1
Supply Chain Management: An International	2
The British Accounting Review	1
The International Journal of Logistics Management	1
Transport Policy	2
Transportation Research Part D: Transport and Environment	2
Transportation Research Part E	2
Transportation Research Part E: Logistics and Transportation Review	1

Table 3: Number of articles for each journal

We also find Demir et al. [34] who have developed a model for sustainable supply management (SSM). This model consists of 7 "building blocks" that influence SSM:

- Reasons for sustainable SSM,
- Criteria employed for SSM,

Country	Number of articles
USA	9
United Kingdom	6
France	5
Canada	4
Italy	4
Germany	3
Australia	2
China	2
Japon	2
Denmark	1
Finland	1
India	1
Malaysia	1
Morocco	1
Netherlands	1
Portugal	1
Republic of Korea	1
Romania	1
Spain	1
Switzerland	1
Taiwan	1
Turkey	1

Table 4: Number of article per country

- Greening supply chains,
- Characteristics of suppliers,
- Managerial approaches for SSM,
- Barriers for SSM,
- Benefits and motivation for SSM.

3.2.2. Road freight transport with sustainability approach

According to Demir et al. [50], road freight transport is a major generator of carbon dioxide emissions. Understanding and mastering different vehicle emission models and their integration into existing optimization methods allow the reduction of emissions in the different transport routes. With a growing global concern for the environment, logistics and freight providers have begun to pay more attention to the negative externalities of their operations, like pollution, accidents, noise, resource consumption, deterioration of land use, and the risk of climate change.

As stated by Demir et al. [27] and Alwakiel et al. [50], [82]-[83], there are many facets to freight transportation planning, especially when considering multiple levels of decision-making. It can be argued that the most well-known problem at this level is the so-called Vehicle Routing Problem (VRP), which consists of determining the least expensive routes to satisfy the demands of a set of customers, subject to lateral constraints. The traditional goal of the standard VRP is to minimize the total distance traveled by all vehicles, but it can be enriched by the inclusion of terms related to fuel consumption.

At the end, we add Ottemoller et al. [84] who provided a summary of the factors affecting energy consumption of vehicles, which can be divided into five categories: car, environment, traffic, and driver operations.

3.2.3. Road freight transport in SCM

According to Croom et al.[19], the importance of supply chain management in relation to freight transport has attracted the attention of various authors in the field of research on freight transport. [85] explain through Figure. 2 three levels of relations between logistics and transport. The first level, the micro level, represents the goals of profit maximizing companies. At this level, transportation is a cost among other costs. Companies have an interest in minimizing transportation costs as well as other types of costs. The second level, the meso level, represents the goals of the supply chain. The development of production systems, following the restructuring of the economy (global, economic, and technological), indicates the need for optimization of the entire supply chain. However, this raises the question of how this development affects transport and the actors involved in transport chains. There is no doubt that the movement of goods influences the transport chains, but the tendencies to optimize the chains can indicate the potential for reducing the amount of transport.

The meso level also includes aggregate objectives at a regional or industrial level. These objectives are often expressed in optimizations of well-being. Transport could have a double-sided influence on these optimizations of well-being. The same influence is marked at the macroscopic level, where society's long-term focus on sustainability and growth is transport-related in two ways. Transport is an integral part of economic restructuring, on the other hand, transport induces a reduction of comfort by environmental burden and congestion. However, the studies that deal quantitatively with the interrelatedness of supply chain management structures and the demand for freight transport are of an aggregated nature; for example, McKinnon et al. [86], who developed a survey of manufacturers, suggests that the growth of truck traffic is the net result of a complex interaction between factors operating at four levels of logistics management: strategic planning of logistics systems, choice of suppliers and distributors, scheduling of product flow, and transportation management resources, or focus on effects such as centralization within logistics structures, according to [87].

With regard to complete models for large-scale freight transport,Tavasszy et al [88] present one of the first approaches to integrating entire supply chains, including logistics. The latest advances in freight transport modeling focus mainly

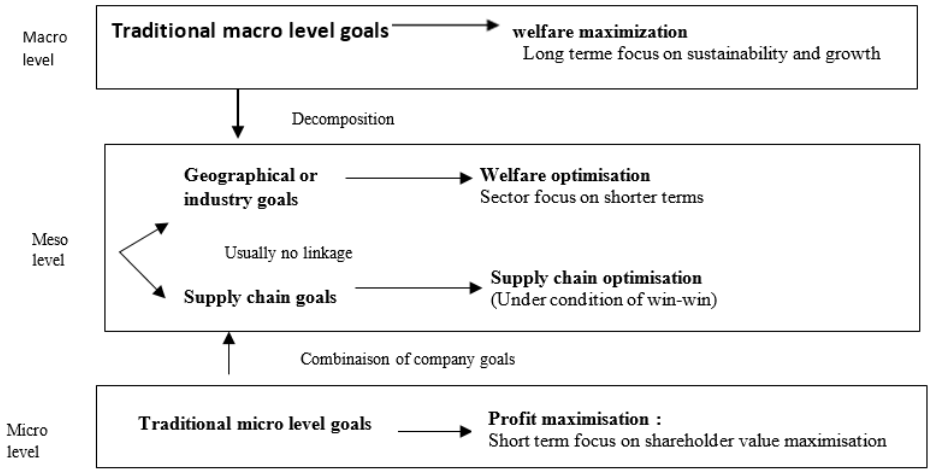

Figure 2: migration towards a supply chain focus [85].

on the capture of logistical aspects and their impact on the demand for freight transport according to Liedtke et al.[89]-[91].

4. CONCLUSION

The study presented in this paper looked at 50 research contributions on environmental sustainability in logistics and transport published between 2000 and 2017. The articles were analyzed according to their main characteristics (year of publication, title of the journal, regions studied, and research methods adopted, and content). The contribution of this paper is twofold: first, it provides a structured review process that can be used as a guide for further research on the topic of environmental sustainability in logistics and transportation; and second, it highlights a number of research questions for future surveys. Current environmental sustainability initiatives among companies carrying out logistics and transport activities have been analyzed in detail, including the rationale for their adoption, the main focus areas in each document, and the present evaluation indicators. It has been observed that the subject of environmental sustainability, road freight transport, and SCM has so far been addressed by several authors, and that several aspects have been studied in depth as evidenced by the examined documents. These objectives are often pursued separately or partially integrated into research approaches as well as into planning tools used by the industry. It becomes imperative to fully and comprehensively include effective methods, strategies, and operations in industrial practise.

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